1. Consider the two vectors in $\mathbb{R}^3$ given by $a = \langle 2, 2, 1 \rangle$ and $b = \langle 0, 3, 4 \rangle$.
   (a) Find the projection of $a$ onto $b$.
   (b) Find the equation of the plane through origin that contains the vectors $a$ and $b$.
   (c) Carefully sketch $a$, $b$, and $\text{pr}_b(a)$ on the $xyz$ axes.

2. Consider the surface given in spherical coordinates by $\rho = \csc \phi$.
   (a) Find the equation for the surface in cylindrical coordinates.
   (b) Find the equation for the surface in Cartesian coordinates.
   (c) Describe the surface and provide a rough sketch of the surface.

3. The equation $2x + y - 2z^2 = -2$ represents a surface in $\mathbb{R}^3$. The intersection of the surface with a plane gives a curve. For each plane listed below, find the equation of the resulting curve and sketch it on axes.
   (a) xy-plane
   (b) xz-plane

4. Consider the curve in $\mathbb{R}^3$ given by $r(t) = \langle t, t^2, 4/t \rangle$ for $1 \leq t \leq 3$, as pictured below.

   (a) Compute the point $p$ on the curve corresponding to $t = 2$. Label the point on the graph above.
   (b) Compute the tangent vector $v$ to the curve at $t = 2$. Carefully draw the vector on the graph above.
   (c) Find the equation of the tangent line to the curve at $t = 2$.

5. Consider the following curve in $\mathbb{R}^3$ and its derivatives given by
   \[ r(t) = \langle \sqrt{3} \sin t, \sin t, 2 \cos t \rangle, \]
   \[ r'(t) = \langle \sqrt{3} \cos t, \cos t, -2 \sin t \rangle, \]
   \[ r''(t) = \langle -\sqrt{3} \sin t, -\sin t, -2 \cos t \rangle. \]
   (a) Find the point $r$, the tangent vector $r'$, and the acceleration vector $r''$ at $t = \pi/3$.
   (b) Find the unit tangent vector $T$ at $t = \pi/3$.
   (c) Find the curvature $\kappa$ at $t = \pi/3$. 